Distribution and Abundance of Macrobenthic Infauna from Boundary and Mud Bays near the British Columbia / U.S. Border.

B.J. Burd, D. Moore and R.O. Brinkhurst

Institute of Ocean Sciences
Department of Fisheries and Oceans
Sidney, B.C. V8L 4B2

1987

Canadian Technical Report of Hydrography and Ocean Sciences No. 84

Canada

87-04330/

Canadian Technical Report of Hydrography and Ocean Sciences

These reports contain scientific and technical information of a type that represents a contribution to existing knowledge but which is not normally found in the primary literature. The subject matter is generally related to programs and interests of the Ocean Science and Surveys (OSS) sector of the Department of Fisheries and Oceans.

Technical Reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report will be abstracted in Aquatic Sciences and Fisheries Abstracts. Reports are also listed in the Department's annual index to scientific and technical publications.

Technical Reports are produced regionally but are numbered and indexed nationally. Requests for individual reports will be fulfilled by the issuing establishment listed on the front cover and title page. Out of stock reports will be supplied for a fee by commercial agents.

Regional and headquarters establishments of Ocean Science and Surveys ceased publication of their various report series as of December 1981. A complete listing of these publications and the last number issued under each title are published in the *Canadian Journal of Fisheries and Aquatic Sciences*, Volume 38: Index to Publications 1981. The current series began with Report Number 1 in January 1982.

Rapport technique canadien sur l'hydrographie et les sciences océaniques

Ces rapports contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles mais que l'on ne trouve pas normalement dans les revues scientifiques. Le sujet est généralement rattaché aux programmes et intérêts du service des Sciences et Levés océaniques (SLO) du ministère des Pêches et des Océans.

Les rapports techniques peuvent être considérés comme des publications à part entière. Le titre exact figure au-dessus du résumé du chaque rapport. Les résumés des rapports seront publiés dans la revue Résumés des sciences aquatiques et halieutiques et les titres figureront dans l'index annuel des publications scientifiques et techniques du Ministère.

Les rapports techniques sont produits à l'échelon régional mais sont numérotés et placés dans l'index à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page de titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Les établissements des Sciences et Levés océaniques dans les régions et à l'administration centrale ont cessé de publier leurs diverses séries de rapports depuis décembre 1981. Vous trouverez dans l'index des publications du volume 38 du *Journal canadien des sciences halieutiques et aquatiques*, la liste de ces publications ainsi que le dernier numéro paru dans chaque catégorie. La nouvelle série a commencé avec la publication du Rapport n° 1 en janvier 1982.

Canadian Technical Report of
Hydrography and Ocean Sciences No.84

1987

DISTRIBUTION AND ABUNDANCE OF MACROBENTHIC INFAUNA FROM BOUNDARY AND MUD BAYS NEAR THE BRITISH COLUMBIA/U.S. BORDER

By

B.J. Burd

D. Moore

R. O. Brinkhurst

Institute of Ocean Sciences
Department of Fisheries and Oceans
Sidney, B.C. V8L 4B2

Copyright Minister of Supply and Services Canada - 1987

ISSN 0711-6764 Cat. No. FS-97-18 /84

Correct citation for this publication:

Burd, B.J., D. Moore and R.O. Brinkhurst. 1987. Distribution and abundance of macrobenthic infauna from Boundary and Mud Bays near the British Columbia/ U.S. border. Can. Tech. Rep. Hydrogr. Ocean Sci. 84.

CONTENTS

Abstract/Resume.....	iv
Introduction.....	1
Methods.....	2
Benthic Invertebrate Samples	2
Sediment Particle Size	2
Statistical Analysis	2
Results.....	6
Benthic Invertebrate Samples	6
Sediment Particle Size	7
Statistical Analysis	7
Discussion.....	11
Acknowledgements.....	12
References.....	13
Appendices	17
Appendix 1 Species list from Boundary Bay	18
Appendix 2 Species Abundances from Boundary Bay	23
Appendix 3 Reference dendrograms with Fowlkes - Mallows statistics	29

ABSTRACT

Burd, B.J., D. Moore and R.O. Brinkhurst. 1987. Distribution and abundance of macrobenthic infauna from Boundary and Mud Bays near the British Columbia/ U.S. border. Can. Tech. Rep. Hydrogr. Ocean Sci. 84.

A study of the nearshore benthic macrofauna in Boundary Bay, British Columbia, was undertaken in November of 1984 to determine the effects of a toxic chemical spill in the connecting river system. Two hundred taxa from 15 stations were identified and enumerated.

It was concluded that the mean abundance of animals per square metre (18,000), mean number of species (37) per station and the similarity in species found in a previous study of Boundary Bay (Smith 1981) indicated that the benthic fauna had not been detectably affected by a toxic chemical spill. There was considerable heterogeneity in animal abundances in nearshore sandy stations, but the actual species complements were fairly consistent. There were no patterns observed in species abundances or complements for intertidal (less than 2.5m depth) vs subtidal sandy stations.

In contrast, the three (deeper) silty stations had more homogeneous faunal compositions, and were characterized by a completely different set of species from the sandy stations, producing a cluster almost 100% dissimilar to the sandy stations.

Cluster analysis of sediment types clearly illustrated that the dissimilarity between the nearshore, sandy and the deeper, silty stations could be explained by differences in sediment texture, whereas the dissimilarities amongst the nearshore sandy stations could not be explained by any factors examined during this study. Variations in abundances of different species in the nearshore sandy stations might be explained in part by sediment and physical characteristics discussed by Swinbanks and Murray (1981), indicating that those stations with eel grass cover tended to have greater animal abundances than those without.

Evaluation of community structures, patchiness and environmental factors of importance in Boundary Bay would require more detailed study.

Keywords: Boundary Bay, benthos, nearshore, benthic macrofauna

RÉSUMÉ

Burd, B.J., D. Moore and R.O. Brinkhurst. 1987. Distribution and abundance of macrobenthic infauna from Boundary and Mud Bays near the British Columbia/ U.S. border. Can. Tech. Rep. Hydrogr. Ocean Sci. 84.

En novembre 1984, les auteurs ont mené une étude de la macrofaune benthique littorale de la baie Boundary (Columbie-Britannique) afin de déterminer l'incidence d'un déversement de produits chimiques toxiques dans le système fluvial. On a ainsi identifié et compté 200 taxons dans les échantillons prélevés a 15 stations.

Les auteurs formulents la conclusion que l'abondance de 18 000 animaux par m2, le nombre moyen de 37 espèces par station et la ressemblance des espèces avec celles identifiées au cours d'une etude anterieure de la baie Boundary (Smith 1981) indiquent que la faune benthique n'a pas été fortement touchée par le déversement de produits chimiques toxiques. On a noté une hétérogéneité élevée de l'abondance des animaux aux stations littorales sablonneuses mais les effectifs réels des espèces étaient assez uniformes. Pour ce qui est de l'abondance et des effectifs, aucun régime n'a été observé aux stations intertidales (moins de 2,5 m de profondeur) par rapport aux stations infratidales sablonneuses.

Par contre, les trois stations en milieux vaseux profond possédaient une faune plus homogène caractérisée par un ensemble d'espèces totalement différent de celui des stations sablonneuses; ceci a mené à un groupement preque 100 % différent de celui des stations sablonneuses peu profondes.

Une analyse de groupements des types de sédiments a clairement révélé que la différence entre les stations littorales sablonneuses et les stations vaseuses en eau profonde peut s'expliquer par des différences de texture de sédiments tandis que la dissimilitude êntre les stations littorales sablonneuses n'a pu etre expliquée par les facteurs étudiés. Les variations de l'abondance des diverses espèces aux stations côtières sablonneuses peuvent être expliquées en partie par les caractéristiques sédimentaires et physiques présentées par Swinbanks et Murray (1981); ainsi, les stations recouvertes de vallisnérie spiralée tendent à abriter un plus grand nombre d'animaux que celles dépourvues de vallisnérie.

L'évaluation des structures de la communauté, de la répartition par taches et des facteurs environnementaux pertinents dans la baie Boundary nécessiterait une étude plus poussée.

Mots-clés: baie Boundary, benthos, littoral, macrofaune benthique

INTRODUCTION

The nearshore benthic community of Boundary Bay on the Pacific Canada/US border and areas near the Serpentine and Nicomekl River estuaries was sampled as part of a cooperative environmental investigation. The study was conducted to analyse the impact of a March 4, 1984 spill of 45,000 L of 2% Sodium tetra/pentachlorophenate (4CP/5CP) into Hyland Creek, which empties into the Serpentine River and thus into Boundary and Mud Bays.

The spill was of concern because of the known toxicity of low concentrations of chlorophenols to a variety of aquatic organisms (Jones 1981, Davis and Hoos 1975, Hauch et al. 1980). Immediately following the spill, a kill of more than 5000 juvenile salmonids and other fish was reported in Hyland Creek (see Colodey 1986). As well, there has been increasing public concern about the cause of a number of grey whale deaths in the Georgia Strait and Puget Sound area over the past few years. For these reasons, the benthic survey was conducted to examine the potential impact on the benthic community of possible toxic buildup in the near shore habitat.

In November 1985, D.F. Moore of the Ocean Ecology Division at the Department of Fisheries and Oceans Institute of Ocean Sciences (IOS) accompanied personnel from the Department of Environment's Environmental Protection Service (EPS) on a cruise to the Mud/Boundary Bay area. EPS sampled chlorophenols and dibenzo-dioxins and -furans and PCB's in sediments, fish, crab and shrimp tissues. The results of this study are summarized in Colodey (1986). There were no significant accumulations of the toxins found in any of the samples and therefore no human health hazards could be identified. There was also no evident impoverishment of the benthic invertebrate community.

Derksen (1985) reported that total chlorophenol concentrations in the water in Hyland Creek fell rapidly following the spill, due in part to flushing and clean-up efforts by EPS (Wilson 1985). Kathman (1985) reported that the impact of the spill on the benthic community in the creek was negligible over the long term. Even 5 weeks after the spill a diverse benthic community was present.

The reasons for the grey whale deaths are still unknown. Previous examinations (Malins et al. 1984) of whale tissue from the Puget Sound area have not shown any accumulations of the toxins discussed in Colodey (1986), but there is still not enough known about the sensitivity of these animals to such toxins.

As well as examining the question of how the spill affected the benthic invertebrate community in Boundary Bay, the current study provided an opportunity to carry out a nearshore benthic survey for comparison with benthic surveys from deeper, more "pristine" offshore habitats in Southern British Columbia.

METHODS

BENTHIC INVERTEBRATE SAMPLES

Two replicate samples at each of fifteen stations in Mud/ Boundary Bay were collected November 14 and 15, 1984 (Table 1 and Figure 1). Each sample was collected using a nine-inch Ponar grab sampler (.05 m2. Samples were collected either from the Canadian research vessel C.S.S. VECTOR or from a Boston Whaler (nearshore).

Each sample was sieved through a 500um screen on board the VECTOR and the filtrate was washed into a "Zip-loc" plastic bag. Buffered 100% formalin with rose bengal stain was added to the bags at a concentration of 10%.

The animals were sorted by D. Moore of IOS and checked for quality control by personnel at E.V.S. Consultants in Sidney, B.C. Identifications were done by the following:

Amphipoda	P. Shaw, PhD candidate, U. British Columbia
Mollusca	R.G.B. Reid, University of Victoria
Echinoderma	W. Austin, Khoyatan Marine Labs
Tanaidacea , Cumacea	W. Austin, ibid
Isopoda	W. Austin, ibid
Pycnogonida	W. Austin, ibid
Leptostraca	W. Austin, ibid
Nemertea	W. Austin, ibid
Polychaeta	H. Jones, Marine Taxonomic Services, Corvallis, Oregon
Ostracoda	J. Word, Battelle NW, Sequim, Washington
Oligochaeta	R.O. Brinkhurst, IOS

SEDIMENT PARTICLE SIZE

EPS collected sediment samples at each of the fifteen stations occupied during the cruise. These data have been included in Table 2 (compliments of A. Colodey, EPS). Mean particle size was determined by seiving the sediment samples from the grabs and box corers through various-sized screens (as described by Krumbein and Pettijohn 1938). When 50% of the sorted sample had accumulated in a particular size class, that class was considered to represent the median particle size.

STATISTICAL ANALYSIS

The species abundance data matrix generated from the sample results was analysed by average linkage cluster analysis, using weighted pair group mean averaging (WPGMA) (Sneath and Sokal 1973) and the compliment of the Bray-Curtis similarity coefficient. This "dissimilarity" coefficient indicates the degree of relative difference in overall species composition and abundance between stations, scaled between 0 and 1. Therefore a dissimilarity close to 1 indicates that two stations are very different relative to all the other stations. Stations or clusters of stations are linked together at the appropriate distances from each other (average

Table 1. Boundary Bay sample locations and depths

Station IOS	Station EPS*	Longitude	Latitude	Depth (m)	Time (PST) Sampled
ASR		122 53'30"	49 04'12"	2.0	Nov14/1430
ANR	MB-2	122 52'18"	49 03'42"	5.0	Nov14/1400
BNW		122 54'20"	49 03'36"	1.5	Nov14/1535
BO		122 53'48"	49 03'18"	9.0	Nov14/1500
BSE		122 53'12"	49 02'54"	1.0	Nov14/1445
CM		122 55'30"	49 01'36"	11.0	Nov15/0940
C5	BB-5	122 53'30"	49 01'30"	6.0	Nov14/1120
C6	BB-6	122 51'54"	49 01'00"	7.0	Nov14/1100
D2	BB-2	123 00'00"	49 00'24"	2.5	Nov15/1840
D3	BB-3	122 58'00"	49 01'24"	5.5	Nov15/0905
D4	BB-4	122 55'36"	49 01'00"	6.0	Nov14/1140
E1	BB-1	123 00'06"	48 59'18"	7.0	Nov14/1200
E7	BB-7	122 56'42"	48 59'24"	38.0	Nov14/0930
E8	BB-8	122 54'24"	48 59'24"	37.0	Nov14/1000
E9	BB-9	122 52'12"	48 59'24"	27.0	Nov14/1030

* From Colodey (1986)

Table 2. Boundary bay sediment types.

Station IOS	Depth (m)	*%silt/clay (<.063mm)	*Vol. Residue Mean %	Sediment Type
ASR	2.0	3	1.9	Sand, Eel grass
ANR	5.0	7	1.5	Sand, Eel grass,Shell
BNW	1.5	0.3	0.7	Sand, Eel grass
BO	9.0	0.2	0.6	Sand
BSE	1.0	0.1	0.6	Sand
CM	11.0	1	5.5	Sand, Shell
C5	6.0	0.6	1.2	Sand
C6	7.0	0.4	0.9	Sand
D2	2.5	0.1	0.5	Sand
D3	5.5	0.2	0.8	Sand
D4	6.0	0.4	0.9	Sand
E1	7.0	0.8	1.1	Sand
E7	38.0	33	7.5	Mud
E8	37.0	40	7	Mud
E9	27.0	39	6.6	Mud/Sand

* From Colodey (1986) - Vol. = volatile
Depths given are water depths at the time of sampling

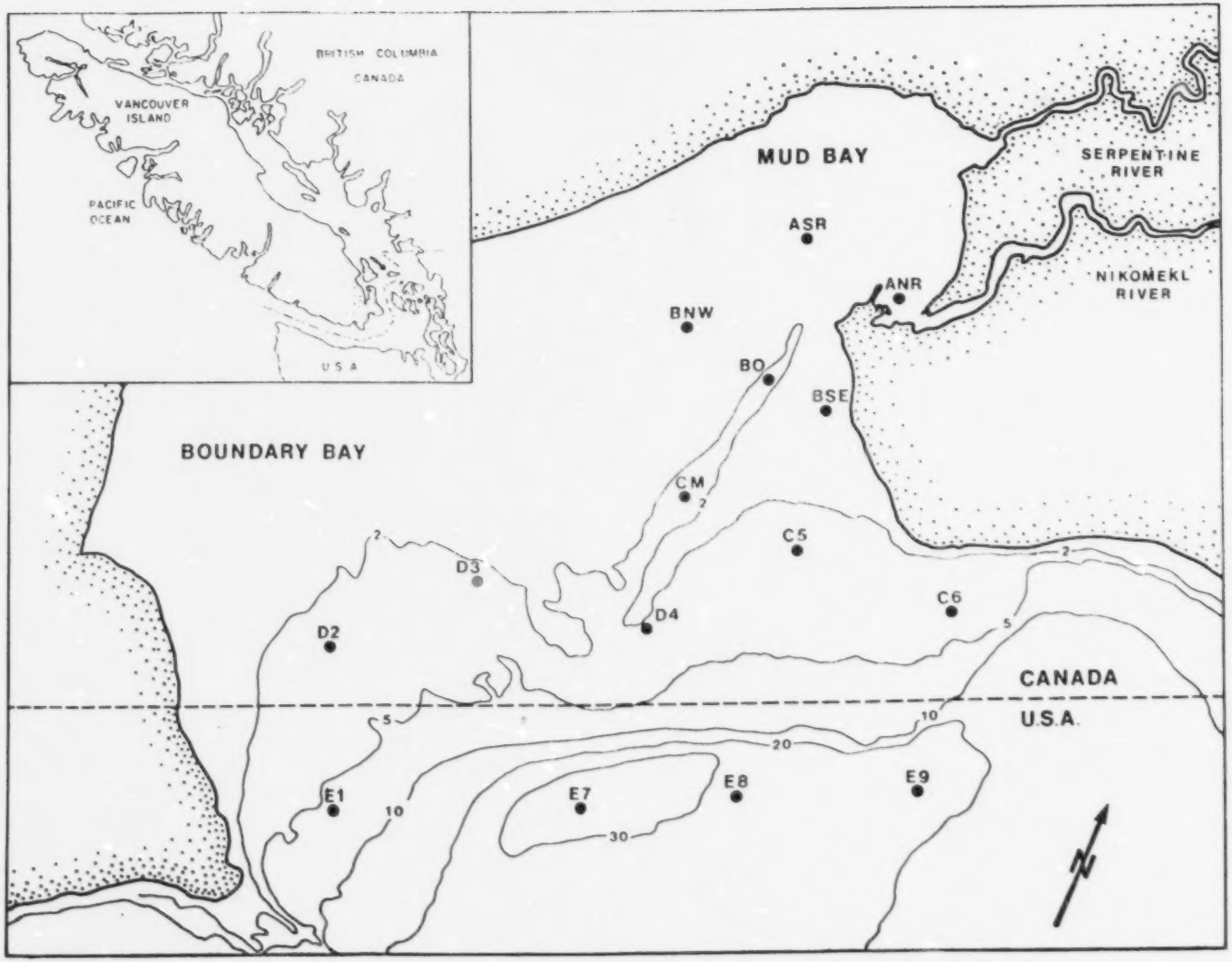


Figure 1. Sample locations in Boundary/Mud Bay, British Columbia and Washington State.

dissimilarity). The significance of each linkage was tested using a "bootstrap" method (Nemec and Brinkhurst - in prep, Diaconis and Efron 1983, Felsenstein 1985). A "p" value of less than 10% was considered to represent a significant ordering of stations at a given linkage level. The dissimilarity between replicates of each station was analysed separately using the compliment of the Bray-Curtis coefficient.

The dendrogram generated from the abundance data dissimilarity matrix was then compared with a preconceived dendrogram generated from a dissimilarity matrix based on (1) geographic distances, (2) differences in silt/clay content and (3) differences between percent volatile residue of sediment between stations. The statistical difference between each of the linkage groupings and levels was then tested using the Fowlkes-Mallow (FM) test statistic.

RESULTS

BENTHIC INVERTEBRATE SAMPLES

Appendix 1 contains the list of species identified during the Boundary Bay study. A total of 200 taxa were identified. Species abundance data for each station replicate are included in Appendix 2. Most of the stations were dominated numerically by nematodes, and several species of bivalves, amphipods and echinoderms. It is notable that almost 100% of the species found at E7-E8-E9 were not found in the remaining stations, and vice versa.

The shallow stations (1-11m depth) were dominated by the bivalves Mysella tumida, Mytilus edulis and Psephidia lordi; the amphipods Corophium ascherusicum, Chierimedia sp., unnamed lyssianassid species, Ampelisca agassizi and Photis brevipes. The tanaid Leptochelia dubia, the cumacean Cumella vulgaris and several ostracods (Philomedidae and Euphilomedes carcharodonta) were also abundant. Polychaetes were less prominent, but the most abundant of these included Armandia brevis, Chaetozone sp. and Ampharete labrops.

The deepwater stations (27-38m depth) were dominated by echinoderms, including Amphiodia urtica and Pentamera sp.; the cumacean Eudorella pacifica and the amphipod Heterophoxus oculatus. Polychaetes were more prominent than in the shallow stations and included Levinsenia gracilis, Nephtys cornuta franciscana and Prionospio cirrifera.

The number of species per station was fairly consistent (Table 2), except for D2 which had about half as many species as the other stations. Stations C5 and D4 had the greatest number of animals per station. Stations BO and D2 and D3 had the smallest numbers of animals per station. Stations BNW and E7-E9 had the lowest abundances of animals among the remaining stations.

SEDIMENT PARTICLE SIZE

Percent silt/clay was between 30-40% at stations E7-E8-E9 (Table 3), and ranged from 0.1 to 7% at all other stations. All stations except E7-E8-E9 had sediment which consisted mainly of fine to medium sand. Stations ASR and ANR had 3 and 7% clay/silt respectively, whereas all other sandy stations had 1% or less silt/clay. Organic content (as estimated from percent volatile residue) was between 0.6 and 5.5 % at the sandy stations, and 6.6 to 7.5% at the silty stations (E7-E8-E9).

STATISTICAL ANALYSIS

The dissimilarity coefficients calculated for the replicates of each station (Table 3) indicate that there is considerable variability in the species composition and abundance in some of the shallow stations. This was particularly true at BNW and D2. Dissimilarity was considerably lower at stations C6,D4 and E1 than at any of the other shallow stations.

The cluster analysis dendrogram shown in Figure 2 is based on a relative abundance matrix of 200 taxa and 15 stations. Data are averaged for the two replicates at each station. Four distinct clusters are evident, with statistically significant groupings ($p<10\%$) in all but the BO-D2-D3 group. Stations E7-E8-E9 are very similar, and are almost 100% different from all the other stations. The 2 clusters represented by C6-E1-D4 and ASR-ANR both have low dissimilarities but are about 85% dissimilar to each other. The remaining stations do not cluster closely with any other stations.

Three distinct clusters with dissimilarity between stations below 0.45 (from Figure 2) are illustrated diagramatically in Figure 3. These are; 1) ASR-ANR; 2) C6-D4-E1; and 3) E7-E8-E9. The remaining stations are scattered between groups 1 and 2. Of these remaining stations, BO, D2 and D3 are distinctly different from the rest of the near-shore sandy stations, because they have comparatively low abundances of animals (Table 3).

The reference dendrograms generated from between-station geographical distance, and differences in percent silt/clay and in volatile residue in sediments are included in Appendix 3. The cluster patterns from the abundance data could not be explained (significance tested using the Fowlkes-Mallows test statistic) by any of the dendrograms generated from the environmental factors mentioned. However, in the dendrogram of sediment silt/clay percentage, the silty stations (E7-E8-E9) were 80% different from all of the nearshore sandy stations (which clustered together with dissimilarities of less than 10%). This is consistent with the differences in species composition found between the nearshore sandy stations and the deeper silty stations (Appendix 2).

Table 3. Total abundance of animals and number of species per station (sum of two replicates), and similarity between replicates for each station.

Station	Abundance per 0.1m2	#Species	Dissimilarity
ASR	1431	40	0.44
ANR	1984	70	0.31
BNW	878	55	0.71
BO	280	43	0.54
BSE	2822	41	0.55
CM	2137	59	0.50
C5	5073	46	0.46
C6	2600	41	0.26
D2	299	20	0.60
D3	499	45	0.31
D4	5110	60	0.24
E1	2042	56	0.28
E7	689	41	0.48
E8	823	43	0.25
e9	409	43	0.44

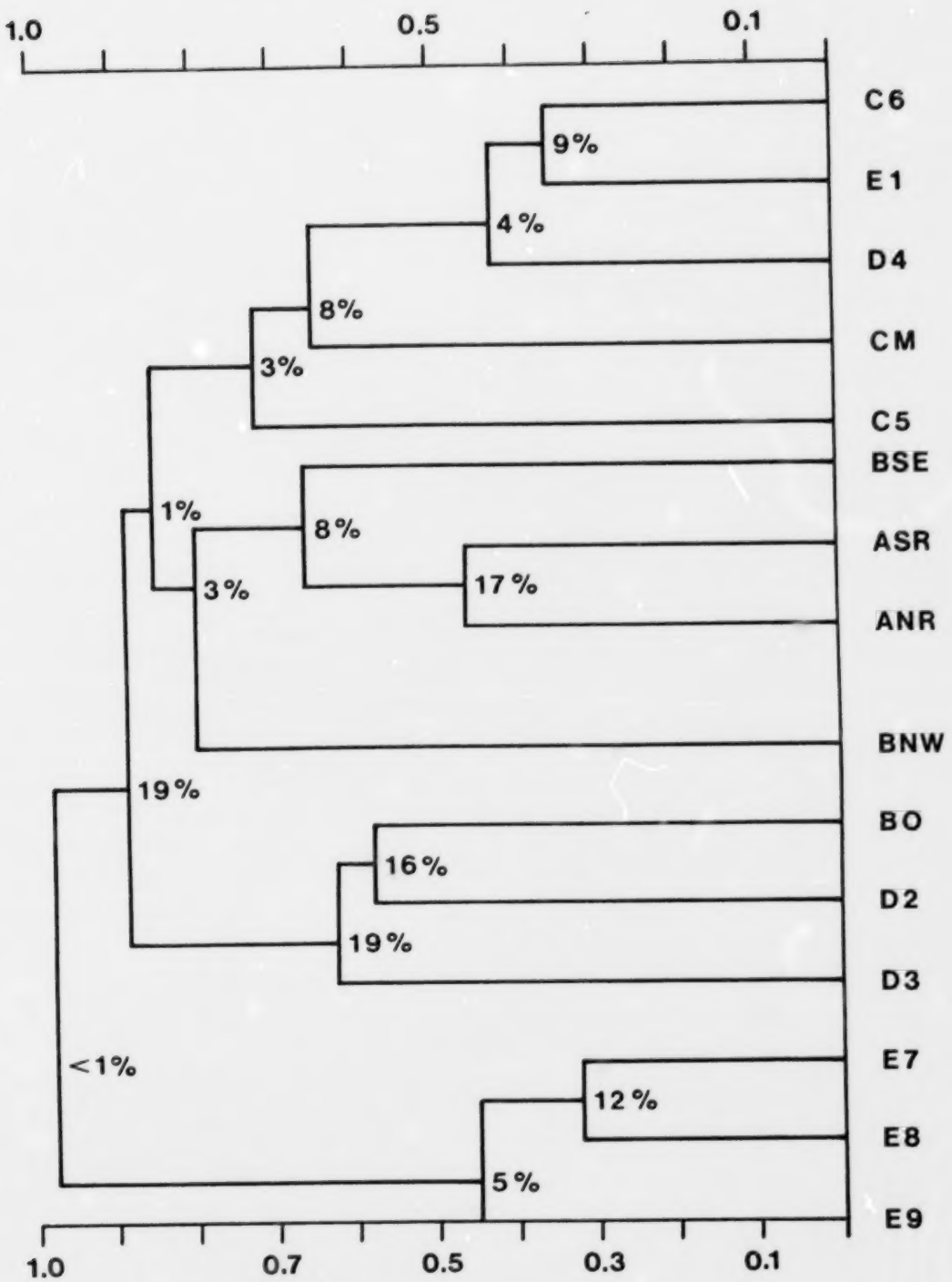


Figure 2. Dissimilarity dendrogram of Boundary Bay abundance data. Numbers represent statistical significance (p) of linkage levels.

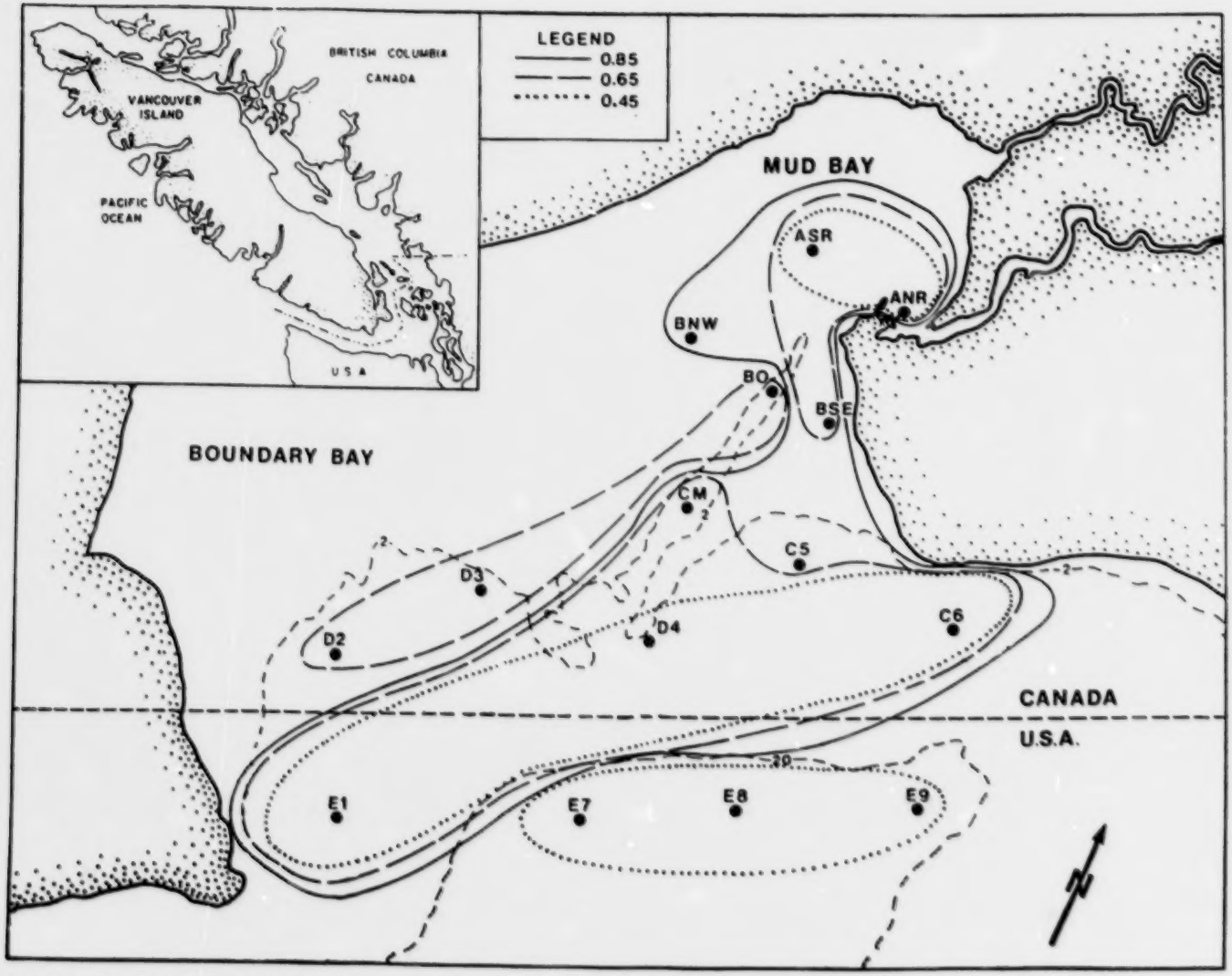


Figure 3. Illustration of cluster groupings. Levels were selected to illustrate the three nearshore, sandy groups and the one deeper, silty group. Depth is in metres.

DISCUSSION

Results of the Boundary/Mud Bay study illustrate the heterogeneity of nearshore estuarine benthic communities. Cluster analysis of the abundance data shows considerable dissimilarity between and within stations, particularly when compared with similar analyses for deepwater benthic communities in British Columbia (Brinkhurst 1987, in prep.) and Puget Sound (Lie 1968, Lie and Evans 1973).

The cluster analysis revealed one significantly distinct community (stations E7-E8-E9) which was about 97% dissimilar to all other stations. This group of stations was distinguished by sediments with 30-40% silt, and a dissimilarity of less than 0.5 between and within stations. The remaining stations clustered into three groups with high dissimilarity between and within stations (up to 80%). All of these remaining stations were characterized by 90% or more sand with low organic content. Examination of the species abundance data (Appendix 2) shows that most of the species present at the sandy stations were not present at the silty stations, and vice versa. The high dissimilarities between the sandy stations were due largely to patchiness in abundance of several species rather than differences in the actual species present. From the evidence of this study alone, it would appear that the sandy stations represent one heterogeneous community, the silty stations another distinct community.

The comparison of cluster patterns for abundance data and sediment particle size (Appendix 3) show that the distinction of the silty stations (E7-E8-E9) can be explained in large part by sediment particle size or organic content of sediment. However, the cluster pattern of sandy stations cannot be explained by differences in sediment particle size or organic content (volatile residue) or by geographic distances between stations. The factors which cause large dissimilarities between the sandy stations could not be determined from this study, but could be explained by previous studies in this area (see below).

The cluster of BO-D2-D3 stands out among the sandy stations because of low abundances of animals (Table 2), making these three stations almost 90% dissimilar to the other sandy stations. Reasons for the impoverishment of the fauna at these three stations are not evident from this study. The total abundance of animals at the silty stations was lower overall than at the sandy stations. Although the sediment organic content was highest at the silty stations, the overlying suspended organic material available for food may be lower than at some of the , sandy stations.

There is no evidence to suggest that any of the stations in the Boundary Bay area have been affected by the toxic spill in Hyland Creek. Colodey (1986) found no detectable chlorophenols at any of the sample stations, and the total abundance of 6000-100,000 animals per m2 and 20-70 species per station (Table 2) are comparable to, or higher than were found by Lie (1968) in Puget Sound stations.

The study most closely comparable study to the present one was that done by Lie (1968) in nearshore locations in Puget Sound. The two studies

are not strictly comparable however, since Lie used 1mm mesh seives for sorting and the present study used 0.5mm seives. This is probably why the most abundant taxon found in the Boundary Bay sandy stations (nematodes) was not found in the Puget Sound stations. Otherwise, there are interesting parallels between the two studies. Lie could not clearly distinguish communities by dominant species (abundance and standing stock) and concluded that the assemblages at the stations represented a "continuum" along an environmental gradient dominated by sediment texture.

There was considerable overlap in the species present at most of the Puget Sound stations. In spite of this, Lie (1968) described some distinctive characteristics of several stations. He concluded that the "nearshore sandy stations" of Puget Sound (5 out of 8) were unlike any benthic community described in the literature. These stations had a silt/clay content of between 3 and 30%, and were dominated by the ostracod Euphilomedes carcharodonta, the molluscs Mysella tumida and Psephidia lordi. These species were also among the dominants (numerically) in the sandy Boundary Bay stations.

Only one station in Puget Sound could be considered to resemble the classic "Amphiodia" community described by Thorson in his review of benthic macrofaunal communities (1957) and illustrated in California by Barnard and Ziesenhenne (1961). This station was characterized by 80-90% silt/clay in the sediment, and dominated by Amphiodia urtica. Pentamera spp. and Eudorella pacifica. The silty stations (E7-E8-E9) in Boundary Bay also had these animals among the numerically dominant species.

The stations studied by Lie (1968) had a wide range of silt/clay contents, whereas the Boundary Bay study did not include any stations with silt/clay between 7 and 27% or over 40%. This may explain why two communities were apparently "distinct" in the Boundary Bay study, but not in the Puget Sound study.

Smith (1981) examined the sand dollar communities in a number of sites in B.C. and Washington, including one station inside and one just outside Boundary Bay. Several of the common species he noted included the cumaceans Lamprops quadriplicata and Cumella vulgaris, the amphipods Synchelidium shoemakeri, Euhaustorius, Anisogammarus pugettensis and Corophium spp., and the polychaete Scoloplos armiger. These species were also common in many of the stations in Boundary Bay sampled during the present study (except E7-E8-E9).

Other studies have been conducted in Boundary Bay, primarily to examine sediment and other physical characteristics of the area and relate them to the flora and fauna (Kellerhals and Murray 1969, Swinbanks and Murray 1981). These authors studied the geology, drainage, salinity, turbidity and tidal characteristics of Boundary Bay in some detail. Using visual counts of specific large macrofauna along transects, Swinbanks and Murray (1981) identified 5 distinct community types. They concluded that in the areas where sand predominated in the substrate, tidal exposure was an important factor delineating communities. Unfortunately, the species identified by Murray and colleagues were usually too large and scattered to be readily obtained in the small grab samples used during the present study.

The studies by Murray and colleagues did suggest possible reasons for the cluster patterns of species observed in the present study. According to the zonation map obtained by Swinbanks and Murray (1981), stations ASR, ANR and BNW fall into the "Eel Grass" zone, with BSE bordering this zone and a zone of shell debris which used to be an oyster lease. Abundances of Mya arenaria, Mysella tumida and Mytilis edulis were high at BSE, since spat of these species would most readily settle and survive on old shell material. These 4 stations cluster together in the analysis of abundance data (Figure 3), although BNW and BSE are dissimilar to ASR and ANR, possibly because of their greater tidal exposure. As well, dense eelgrass growth extends seaward along the tidal channels into the subtidal zone below the "lower sand wave zone", which may include CM,C5,D4,C6, and E1. That would explain the similarity between the cluster of the 4 nearshore stations, and that of the 5 deeper stations (Figure 3).

Eel grass in these areas dies back in winter, leaving only isolated patches (Swinbanks and Murray 1981), which would explain why it was not observed at some stations during either our November 1984 cruise or the original late-winter 1966 cruise reported by Kellerhals and Murray (1969). As well, considerable quantities of eel grass are uprooted by winter storms and carried up onto the shore.

The cluster of low abundance stations including BO, D2 and D3 occurs just beyond the edge of the intertidal zone, and may still be in the subtidal region of the "lower sand wave zone" which lacks floral cover. Swinbanks and Murray noted that abundances of the faunal species they sampled were very low in this zone. As well, Kellerhals and Murray (1969) reported coarse sands along the lower perimeter of this zone (farthest from shore), presumably due to strong wave action. Unfortunately, the sediment sorting done by Colodey (1986 -see Table 2) did not distinguish sand-grain sizes, so that it is impossible to tell if BO, D2 and D3 indeed had coarser sand than did the other stations. Species abundances in BO, D2 and D3 may therefore be low due to turbulence generated by breaking of waves along the tidal flat at low tide.

ACKNOWLEDGEMENTS

This study was undertaken by the Ocean Ecology Division of the Institute of Ocean Sciences in Sidney, B.C. under the supervision of Dr. R.O. Brinkhurst. Field sampling and primary sorting were carried out by D. Moore of the Ocean Ecology Division. Taxonomic identifications and verifications of all groups except Oligochaeta were performed by E.V.S. Consultants Ltd. (P. Chapman, project manager) and their colleagues. Data analysis and manuscript preparation were carried out by B. Burd of Galatea Research, with editing by L. Giovando of IOS. The statistical analyses in this study were based on methods developed by A. Nemec (DSS Contract #FP941-6-0387-01SB), who contributed generously of her time to improve and modify the programs for use in this project. The methodology for these analyses is currently in preparation for publication.

The authors thank all participants for their dedication. Special thanks are extended to Mr. A. Colodey and other members of the Environmental Protection Service for their cooperation and support in carrying out this study.

REFERENCES

Barnard, J.L. and F. Ziesenhenne. 1961. Ophiurid communities of southern California coastal bottoms. Publs. St. Wat. Pollut. Control Bd. Calif. vol. 2: 131-152.

Brinkhurst, R.O.(ed). In prep. Distribution and abundance of macrosopic benthic infauna from the continental shelf off southwestern Vancouver Island, British Columbia, Canada. Can. Tech. Rep. Hydrog. Ocean Sci. No. 00. (in prep.)

Colodey, A. 1986. Investigations in Boundary Bay and Geogia Strait following a chlorophenate spill. Environment Canada Regional Program Report 86-16.

Davis, J.C. and R.A.W. Hoos. 1975. Use of sodium penta- chlorophenate and dehydroabietic acid as reference toxicants for salmonid bioassays. J. Fish. Res. Bd. Can. 32: 411.

Derksen, G. 1985. Hyland Creek - Compilation of penta/tetrachlorophenol receiving water data and observed trends. File Report. September 1985. Environment Canada, West Vancouver, B.C.

Diaconis, P. and B. Efron. 1983. Computer-intensive methods in statistics. Sci. Amer. 248 (5): 96-108.

Felsenstein, J. 1985. Confidence limits on phylogenies: An approach using the bootstrap. Evolution 39(4): 783-791.

Hauch, R.G., D.R. Norris and R.H. Pierce Jr. 1980. Acute and chronic toxicity of sodium pentachlorophenate to the copepod, Pseudodiaptomus coronatus. Bull. Environ. Contam. Toxicol. 25(4): 562-568.

Jones, P.A. 1981. Chlorophenols and their impurities in the Canadian environment. Economic and technical Review Report: EPS 3-EC-81-1. Environmental Protection Service, Ottawa.

Kathman, R.D. 1985. Benthic invertebrates of Hyland Creek, Cloverdale, B.C. following a penta/tetrachlorophenol spill. (E.V.S. Consultants Project No. 4712) Prepared for Environmental Protection Service, West Vancouver, B.C.

Kellerhals, P. and J.W. Murray. 1969. Tidal flats at Boundary Bay, Fraser River delta, British Columbia. Bull. Can. Pet. Geol. 17 (1): 67-91.

Krumbein, W.C. and F.J. Pettijohn, 1938. Manual of sedimentary petrography. Appleton-Century-Crofts, Inc. New York. 549pp.

Lie, U. 1968. A quantitative study of benthic infauna in Puget Sound, Washington, U.S.A., in 1963-1964. FiskDir. Skr. (Ser. Havunders.) Vol 14, No. 5. 229-556.

Lie, U. and R.A. Evans. 1973. Long-term variability in the structure of subtidal benthic communities in Puget Sound, Washington, USA. Mar. Biol. 21: 122-126.

Malins, D.C., D.W. Brown and Sin-Lam Chan. 1984. Chemical analyses from deceased gray whale. Environmental Conservation Division. Northwest and Alaskan Fisheries Center, Seattle (unpublished report).

Nemec, A. and R.O. Brinkhurst. In prep. Using the bootstrap to assess statistical significance in the cluster analysis of species abundance data.

Smith, A.L. Comparison of macrofaunal invertebrates in sand dollar (Dendraster excentricus) beds and in adjacent areas free of sand dollars. Mar. Biol. 65: 191-198.

Sneath, P.H.A. and R.R. Sokal. 1973. Numerical taxonomy. W.H. Freeman. San Francisco.

Swinbanks, D.D. and J.W. Murray. 1981. Biosedimentological zonation of Boundary Bay tidal flats, Fraser River delta, British Columbia. Sedimentology 28: 201-237.

Thorson, G. 1957. Bottom communities. Mem. Geol. Soc. Am. Vol 67: 461-534.

Wilson, D.M. 1985. Chlorophenols in the British Columbia environment paper presented at: control of chemical releases from wood treating facilities - An EPS Chemical Management Workshop. March 1985.

APPENDICES

Appendix 1. Boundary Bay Species List - to be read columnwise

PHYLUM CNIDARIA
CLASS ANTHOZOA
ORDER ACTINIA

PHYLUM PLATYHELMINTHES
CLASS TURBELLARIA
ORDER POLYCLADIDA

PHYLUM NEMATODA
No Identifications

PHYLUM NEMERTEA
ORDER HOPLONEMERTEA
Fam. Cerebratulidae
Cerebratulus sp.

ORDER HETERONEMERTEA
Fam. Emplectonematidae
Emplectonema gracile

PHYLUM ECHINODERMATA
CLASS OPHIUROIDEA
ORDER OPHIURIDA
Fam. Amphiuridae
Amphiodia urtica
Amphiodia sp. juv.
Amphiodia periercta

CLASS ECHINOIDEA
SUPERORDER GNATHOSTOMATA
Fam. Dendrasteridae
Dendraster excentricus

CLASS HOLOTHUROIDEA
ORDER DENDROCHIROTIDA
Fam. Paracucumidae
Pentamera sp.

PHYLUM MOLLUSCA
CLASS GASTROPODA
ORDER ARCHAEOGASTROPODA
Fam. Trochidae
Solariella varicosa

Fam. Scaphandridae
Acteocina culcitella

Fam. Cylinchidae
Cyclinchna alba

Fam. Gastropteridae
Gastroperton pacificum

Fam. Atyidae
Hamineoa vesicula

Fam. Lacunidae
Lacuna porrecta

Fam. Rissoidae
Alvania compacta
Alvania .burrardensis
Alvania compacta

Fam. Columbellidae
Nitidella gouldi
Mitrella tuberosa

Fam. Naticidae
Natica clausa

Fam. Rissoidae
Risoina newcombeii

Fam. Muricidae
Urosalpinx cinerea

Fam. Pyramidellidae
Turbonilla aurantia
Turbonilla pedroana

Fam. Calyptreidae
Crepidula adunca

ORDER SCAPHOPODA
Fam. Dentaliidae
Dentalium pretiosum

CLASS BIVALVIA
Fam. Nuculidae
Acila castrensis
Nucula tenuis

Fam. Thyasiridae
Adontorhina cyclia
Axinopsida serricata

Fam. Astartidae
Astarte alaskensis

Fam. Moliolinae
Dacrydium vitreum

Appendix 1. Continued

Fam. Nactridae
Spisula falicata

Fam. Cordiidae
Clinocardium nuttalli

Fam. Veneridae
Compsomyax subdiaphana
Venerupis japonica
Psephidia lordi
Transennella tantilla
Humilaria kennerleyi

Fam. Naticidae
Lunatia pallida

Fam. Tellinidae
Macoma inconspicua
Tellina carpenteri
Tellina modesta
Tellina nuculoides

Fam. Myidae
Mya arenaria

Fam. Kelliidae
Mysella tumida

Fam. Mytilidae
Mytilus edulis

Fam. Nuculanaidae
Nuculana hamata
Yoldia myalis

Fam. Tapetinae
Tapes philippinarum
Prototheca staminea

PHYLUM ANNELIDA
CLASS POLYCHAETA
Fam. Syllidae
?Diplosyllis sp.
Exogone louri

Fam. Ampharetidae
Amage anops
Ampharete labrops

Fam. Aricidae
Aricidea lopezi
Aricidea nr. suecica

Fam. Opheliidae
Armandia brevis

Fam. Capitellidae
Capitella capitata complex
Capitellidae sp.
Mediomastus californiensis
Mediomastus sp.
Travisia brevis

Fam. Cirratulidae
Chaetozone sp.
Tharyx sp.

Fam. Sabellidae
Chone ecaudata

Fam. Hesionidae
Micropodarke dubia

Fam. Cossuridae
Cossura longocirrata

Fam. Dorvilliidae
Dorvillea sp.

Fam. Phyllodocidae
Eteone longa
Eteone sp.
Eumida sanguinea

Fam. Glyceridae
Glycera capitata
Glycera picta

Fam. Goniadidae
Glycinde armigera
Goniada brunnea

Fam. Hesionidae
Hesionidae sp.

Fam. Orbiniidae
Leitoscoloplos pugettensis
Scoloplos acmeceps
Scoloplos armiger

Appendix 1. (continued)

Fam. Lumbrineridae
Lumbrineris bicirrata
Lumbrineris cruzensis
Lumbrineris sp.

Fam. Maldanidae
Maldanidae sp.
Axiothella rubrocincta

Fam. Owediidae
Myriochele heeri
Owenia fusiformis

Fam. Hesionidae
Kefersteinia cirrata

Fam. Nephtyidae
Nephtys assignis
Nephtys caecoides
Nephtys ciliata
Nephtys cornuta franciscana
Nephtys longosetosa
Nephtys nr. californiensis
Nephtys sp.

Fam. Paraonidae
Levinsenia gracilis

Fam. Nereidae
Nereis ?procera
Nereis sp.
Nereis zonata
Platynereis bicanaliculata

Fam. Onupidae
Onuphis iridescens
Onuphis sp.

Fam. Spionidae
Paraprionospio pinnata
Polydora socialis
Pygospio elegans
Prionospio cirrifera
Prionospio steenstrupi
Spiophanes berkeleyorum
Spiophanes bombyx
Streblospio benedicti
Malacroceros glutaeus
Malacoceros sp.

Fam. Pholoidae
Pholoe minuta

Fam. Phylodocidae
Phyllodoce hartmani
Phyllodoce mucosa
Phyllodoce sp.
Phyllodoce williamsi

Fam. Paraonidae
Paraonella platybranchia

Fam. Chrysopetalidae
Paleonotus bellis

Fam. Terebellidae
Polycirrus sp. complex

Fam. Polynoidae

Fam. Dorvilleidae
Protodorvillea gracilis

Fam. Apistobranchidae
Scolelepis foliosa

Fam. Phaerotidae
Sphaerodoropsis sphaerulifer

Fam. Spirorbidae
Spirorbis sp.

Fam. Sternapsidae
Sternapsis scutata

CLASS OLIGOCHAETA
ORDER TUBIFICIDA
Fam. Tubificidae
Limnodriloides sp.
Tubificoides wasselli
Tubificoides brownae
Tubificoides diazi

Fam. Enchytraeidae

Appendix 1. (continued)

PHYLUM ARTHROPODA
CLASS PYCNOGONIDA
Fam. Phoxichilidiidae
Phoxichilidium femoratum

Fam. Ammotheidae
Achelia nudiuscula

CLASS CRUSTACEA
ORDER MYSIDACEA
Fam.
Archaeomysis grebnitzkii

ORDER OSTRACODA
Fam. Philomedidae
Euphilomedes carcharodonta
Euphilomedes producta
Euphilomedes sp.
Scleroconcha trituberulata

Fam. Bathylagidae
Bathyleberis

ORDER CUMACEA
Fam. Diastylidae
Diastylis alaskensis
Diastylopsis tenuis

Fam. Leuconidae
Eudorella pacifica

Fam. Lampropidae
Lamprops quadriplicata

Fam. Nannostacidae
Cumella vulgaris
Cumella sp.

ORDER LEPTOSTRACA
Fam. Nebaliidae
Nebalia pugettensis

ORDER TANAIDACEA
Fam. Tanaidae
Sinelobus stanfordi

Fam. Leptognathia
Leptochelia dubia

ORDER ISOPODA
Fam. Arcturidae
Synidotea bicuspida
Idotea resecata
Idotea sp.

Fam. Paramunnidae
Pleurogonium rubicundum

Fam. Munnidae
Munna ubiquita

ORDER AMPHIPODA
Fam. Ampeliscidae
Ampelisca agassizi
Ampelisca pugetica
Ampelisca careyi

Fam. Atylidae
Atylus collingi

Fam. Dexaminidae
Guernea reduncans

Fam. Photidae
Photis brevipes?
Photis sp.
Cheirimedia sp.
Protomedia fasciculata

Fam. Corophiidae
Corophium ascherusicum

Fam. Ischyroceridae
Ischyrocerus anguipes

Fam. Amphithoidae
Ampithoe sp.

Fam. Oedicerotidae
Monoculodes sp.
Westwoodilla caecula
Synchelidium shoemakeri

Fam. Phoxocephalidae
Grandifoxus sp.
Foxiphalus sp.
Heterophoxus oculatus

Fam. Haustoriidae
Eohaustorius sp.

Fam. Lysianassidae
lysianassid spp.
Lepidecreum

Appendix 1. (continued)

Fam. Hyalidae
Allorchestes angusta

Fam. Melitidae
Melita dentata

Fam. Caprellidae
Caprella sp.

Fam. Podoceridae

ORDER CIRRIPEDIA
Fam. Balanidae
Balanus crenatus

ORDER LEPTOSTRACA
Fam. Nebalidae
Nebalia pugettensis

ORDER DECAPODA
Fam. Pinnotheridae
Pinnixa occidentalis

Fam. Brachyura
Cancer majister

Appendix 2. Boundary Bay Benthos Abundance Data

TAXON	ASR 1	ASR 2	ANR 1	ANR 2	BHW 1	BHW 2	BO 1	BO 2	BSE 1	BSE 2	C4 1	C4 2	C5 1	C5 2	C6 1	C6 2	D2 1	D2 2	D3 1	D3 2	D4 1	D4 2	E1 1	E1 2	E7 1	E7 2	E8 1	E8 2	E9 1	E9 2
PHYLUM CNIDARIA																														
CLASS ANTHOZOA																														
ORDER ACTINIA	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PHYLUM PLATYHELMINTHES																														
CLASS TURBELLARIA																														
ORDER POLYCLADIDA	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
Turbellarian	0	0	4	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
PHYLUM NEMATODA	477	145	195	405	14	105	11	35	28	159	292	142	2484	1056	208	208	26	5	19	49	420	393	244	360	6	5	1	2	3	6
PHYLUM NEMERTEA																														
HOPLONEMERTEA	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Cerebratulus sp.	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Nemertea	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paplectonema gracile	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PHYLUM ECHINODERMATA																														
CLASS STELLEROIDEA																														
Asphiodia urtica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	31	32	49	0	18
Asphiodia sp. juv.	0	0	0	0	0	0	0	0	0	0	4	4	3	0	7	3	0	0	0	0	5	6	0	2	0	63	52	32	0	28
Asphiodia periercta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
CLASS ECHINOIDEA																														
Dendraster excentricus	0	0	0	0	3	0	5	5	1	0	1	0	1	0	0	0	1	5	7	8	0	1	0	0	0	0	0	0	0	0
CLASS HOLOTHUROIDEA																														
Pentamera sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57	162	52	63	12	23
PHYLUM MOLLUSCA																														
CLASS GASTROPODA																														
Acteocina culcitella	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	3	0
Cylichna alba	4	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Dacrydium vitreum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	2	0	6	0	0	0
Gastropteron pacificum	0	1	0	0	0	0	0	0	0	4	0	1	2	0	0	0	0	1	0	0	0	1	0	0	0	0	0	6	0	0	0
Haminoea vesicula	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1	0	0	0
Lacuna porrecta	0	0	0	0	0	0	3	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Mitrella tuberosa	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Natica clausa	0	0	0	0	0	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0
Nitidella gouldi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ristorina newcombeii	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Spisula falicata	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
Turbonilla aurantia	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Turbonilla pedrosna	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Urosalpinx cinerea	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Venerupis japonica	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 2. (continued)

TAXON	ASR 1	ASR 2	ASR 1	ASR 2	BSW 1	BSW 2	BO 1	BO 2	BSE 1	BSE 2	CK 1	CK 2	CS 1	CS 2	CS 1	CS 2	D2 1	D2 2	D3 1	D3 2	D4 1	D4 2	E1 1	E1 2	E7 1	E7 2	E8 1	E8 2	E9 1	E9 2
CLASS BIVALVIA																														
Acila castrensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	9	3	2	0	15
Adontorhina cyclia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Alvania compacta	0	0	2	1	0	0	0	21	0	0	0	64	0	0	0	0	0	0	3	0	4	0	23	20	3	0	0	0	0	0
Alvania hurrardensis	0	0	0	0	0	0	0	0	0	0	76	1	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	2	0
Alvania compacta	0	0	0	0	0	0	2	0	0	0	24	0	0	1	9	0	0	0	0	0	0	15	0	0	0	0	1	0	0	0
Astarte alaskensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Axinopsida serricata	0	0	3	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	4	8	5	0	7
Clinocardium nuttalli	0	0	0	4	4	7	1	4	0	0	7	8	0	0	0	0	0	0	3	1	1	0	0	0	0	0	0	0	0	0
Compsomyax subdiaphana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Crepidula adunca	0	0	9	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dentalium pretiosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Humilaria kennerleyi	2	0	0	1	1	1	2	1	0	0	8	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0
Lunatia pallida	0	0	5	0	13	2	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0
Macoma inconspicua	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mya arenaria	1	1	0	0	4	0	0	0	21	48	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mysella tumida	35	13	25	1	1	0	2	12	73	69	72	48	0	2	273	480	0	2	5	3	320	430	96	65	12	3	8	4	0	0
Mytilus edulis	0	0	5	1	3	20	0	3	111	122	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Mucula tenuis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	8	5	5
Muculana hamata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Prototheca staminea	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psephidia lordi	0	0	6	0	0	0	12	32	0	2	83	0	0	0	28	8	18	46	31	32	256	231	81	96	0	0	1	0	1	2
Solariella varicosa	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0
Tapes philippinarum	0	0	0	0	0	0	0	0	9	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellina carpenteri	1	3	5	1	0	0	0	0	0	2	11	99	6	3	10	2	0	0	1	2	24	16	7	2	0	1	1	0	1	0
Tellina modesta	0	0	0	1	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellina nuculoides	0	0	0	1	0	0	1	0	0	0	0	0	2	0	2	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0
Transennella tantilla	0	0	0	0	2	0	0	0	0	0	1	192	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yoldia myalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0
PHYLUM ANNELIDA																														
CLASS POLYCHAETA																														
?Diplosyllis sp.	0	0	0	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ampe anops	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ampharete labrops	0	2	47	42	0	7	0	0	0	0	10	5	0	0	0	0	0	0	7	2	2	7	5	5	0	0	0	0	0	0
Aricoidea lopezi	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Aricidea nr. suecica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Armandia brevis	12	32	40	27	0	2	1	3	37	93	1	0	22	2	6	21	0	0	0	0	0	5	6	9	0	0	0	0	0	0
Asciothella rubrocincta	0	0	0	5	0	0	0	4	0	0	0	0	12	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Capitella capitata complex	48	13	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
Capitellidae sp.	13	9	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	0	1
Chaetozone sp.	21	3	5	2	1	136	9	7	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0
Chone scaudata	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cirratulidae	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	1	0	0	0
Cossura longocirrata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	4	8	2	10
Darvillea sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 2. (continued)

TAXON	ASR 1	ASR 2	ANR 1	ANR 2	BNW 1	BNW 2	BO 1	BO 2	BSE 1	BSE 2	CM 1	CM 2	C5 1	C5 2	C6 1	C6 2	D2 1	D2 2	D3 1	D3 2	D4 1	D4 2	E1 1	E1 2	E7 1	E7 2	EB 1	EB 2	E9 1	E9 2
Etecne longa	0	1	0	0	0	0	0	0	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Etecne sp.	0	0	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Exmida sanguinea	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0
Eungone louri	0	0	2	0	0	2	0	0	0	0	0	7	0	0	36	20	0	0	8	8	0	0	0	2	0	0	0	0	0	0
Glycera capitata	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	3	0	2	0	0	1	1	0	0
Glycera nicta	7	4	9	12	0	4	0	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Glycinde armigera	0	0	0	0	0	0	0	0	5	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Goniada brunnea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hesionidae sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kefersteinia cirrata	0	0	1	1	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leitoscoloplos pugettensis	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	10	31	10	42	8	13
Levinsenia gracilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Lumbrineris bicirrata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	4
Lumbrineris cruzensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	16	2	2	5	13
Lumbrineris sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Malacoceros glutaeus	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	4	0	0	0	0	0	0	1	0	0	0
Malacoceros sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	2	0	0	0	0	0	0	0	0	0	0
Maldanidae sp.	0	0	0	1	1	1	9	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	2	0	4
Mediomastus californiensis	0	0	0	0	0	0	0	0	0	0	0	1	6	0	1	0	0	0	0	0	0	3	9	1	0	1	0	2	2	4
Mediomastus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropodarke dubia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Myriochele heeri	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Nephtys assignis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Nephtys caecoides	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Nephtys ciliata	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	18	18	23	16	5	23
Nephtys cornuta franciscana	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Nephtys longosetosa	0	0	3	4	1	3	0	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	0	1	0
Nephtys nr. californiensis	0	0	3	5	12	0	0	0	0	0	3	5	0	0	0	0	0	0	0	12	0	1	0	0	0	0	0	0	0	1
Nephtys sp.	1	0	3	1	0	2	0	0	1	0	1	0	3	0	0	0	0	0	0	2	0	3	0	0	0	0	0	0	0	0
Nereidae sp.	0	0	0	0	0	0	0	0	0	0	0	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nereis ? procera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Nereis sp.	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	3	0	1	0	0	0	0	0	0
Nereis zonata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	2	0	0	0	0	0	0
Onuphis iridescens	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	40	50	49	60	13	14	0	0	0	0	0	0
Onuphis sp.	0	1	37	48	1	2	0	0	0	0	201	266	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Owenia fusiformis	0	0	13	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3
Paleonotus bellis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	7	0	0	0
Paraprionospio pinnata	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	13	3	4
Paronella platybranchia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pholoe minuta	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0
Phyllodoce hartmani	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phyllodoce mucosa	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Phyllodoce sp.	0	0	1	0	0	0	0	0	0	0	0	0	2	0	1	2	0	0	0	0	0	8	1	0	0	0	0	0	0	0
Phyllodoce williamsi	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	22	1	0	0	0	0	0	0	0
Platynereis bicanaliculata	0	0	26	16	2	16	0	0	1	0	1	0	0	0	1	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Polychaeta indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 2. (continued)

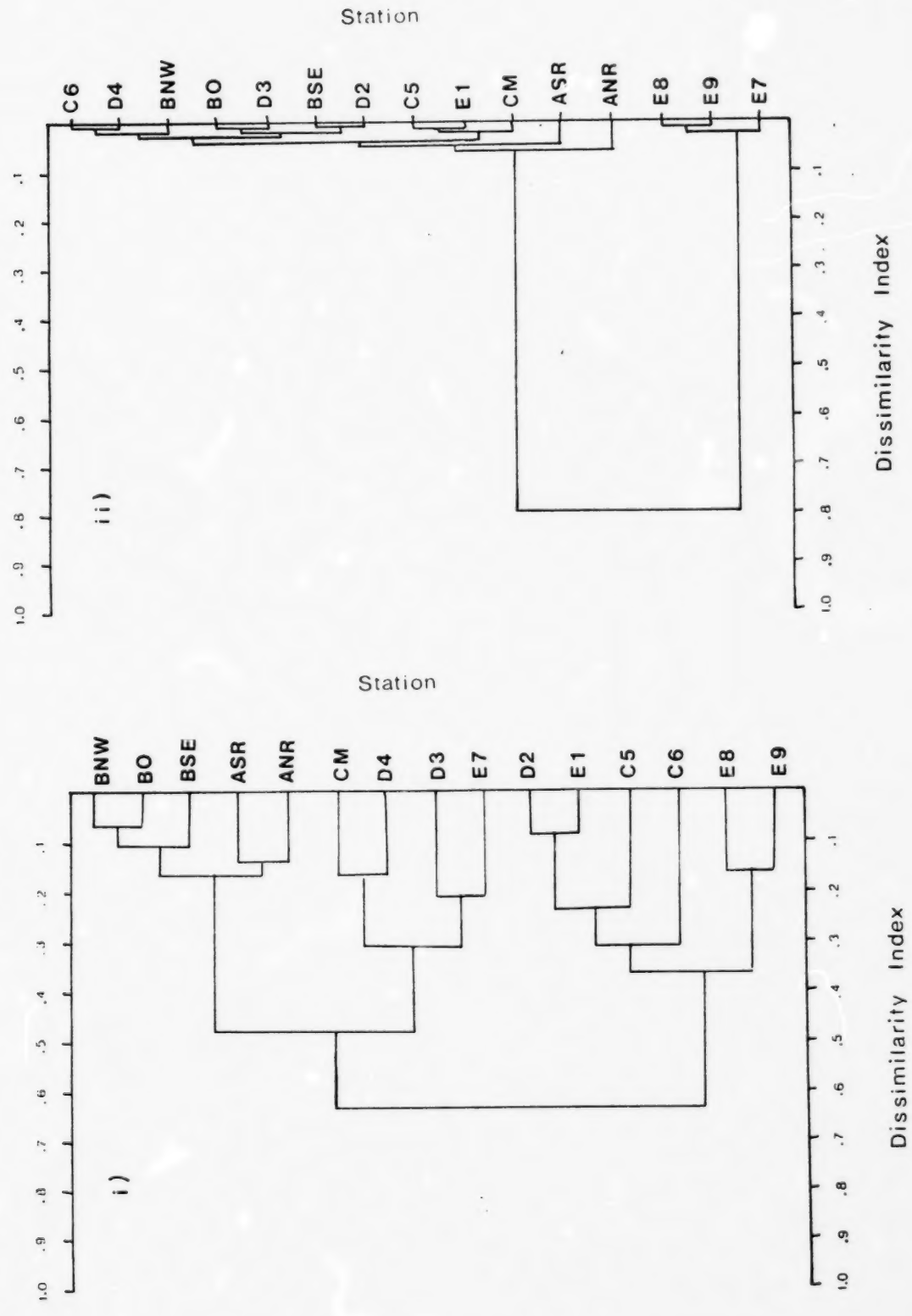
TAXON	ASR 1	ASR 2	AMR 1	AMR 2	BMW 1	BMW 2	BO 1	BO 2	BSE 1	BSE 2	C4 1	C4 2	C5 1	C5 2	C6 1	C6 2	D2 1	D2 2	D3 1	D3 2	D4 1	D4 2	E1 1	E1 2	E7 1	E7 2	E8 1	E8 2	E9 1	E9 2
Polycirrus sp. complex	0	0	0	1	4	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polydora kempi	1	1	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Polydora socialis	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Polynoidae sp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	1	0	0	3	0	1
Prionospio cirrifera	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	3	0	0	0	0	0	1	1	7	6	8	6	23	10	7
Prionospio steenstrupi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Protodorvillea gracilis	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pygospio elegans	36	11	0	0	4	5	0	0	1	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scoletepis foliosa	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scoloplos acmeceps	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Scoloplos armiger	1	0	0	0	4	0	6	11	45	32	0	0	0	0	0	0	0	0	4	10	0	0	1	1	0	0	0	0	0	0
Sphaerodoropsis sphaerulife	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Spionidae sp.	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spiophanes berkeleyorum	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Spiophanes bombyx	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	3	2	22	6	6	0	0	0	0	0	0
Spirorbis sp.	0	0	0	0	0	2	1	5	0	0	0	0	0	0	0	0	0	0	1	0	5	3	0	0	0	0	0	0	0	0
Streblospio benedicti	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syllidae sp.	0	0	0	2	0	1	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tharyx sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
Travisia brevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Polychaete frag.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0
Sternaspis scutata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
CLASS OLIGOCHAETA																														
Tubificoides diazi	0	0	3	0	0	0	0	0	0	0	12	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnodriloides sp.	0	0	0	1	0	1	0	10	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Tubificoides wasselli	0	0	8	11	0	7	2	0	0	1	0	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2	5	2	3
Tubificoides brownae	20	29	9	10	0	13	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Enchytraeids	0	0	0	0	1	0	1	0	0	9	0	5	5	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Oligochaeta	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PHYLUM ARTHROPODA																														
CLASS PYCNOGONIDA																														
Phoxichilidium femoratum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Achelia nudiuscula	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLASS CRUSTACEA																														
ORDER MYSIDACEA																														
Archaeomysis grebnitzkii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
ORDER OSTRACODA																														
Euphilomedes carcharodonta	0	0	0	0	0	0	0	0	0	0	110	0	53	4	0	66	0	0	0	0	0	0	0	31	0	0	3	3	0	0
Philomedidae juv.	0	0	0	0	0	0	0	0	0	0	51	0	51	14	0	95	0	0	0	0	0	0	0	66	0	0	0	0	0	0
Sclerocoucha trituberulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0
Euphilomedes producta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	1	0
Euphilomedes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bathyleberis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

Appendix 2. (continued)

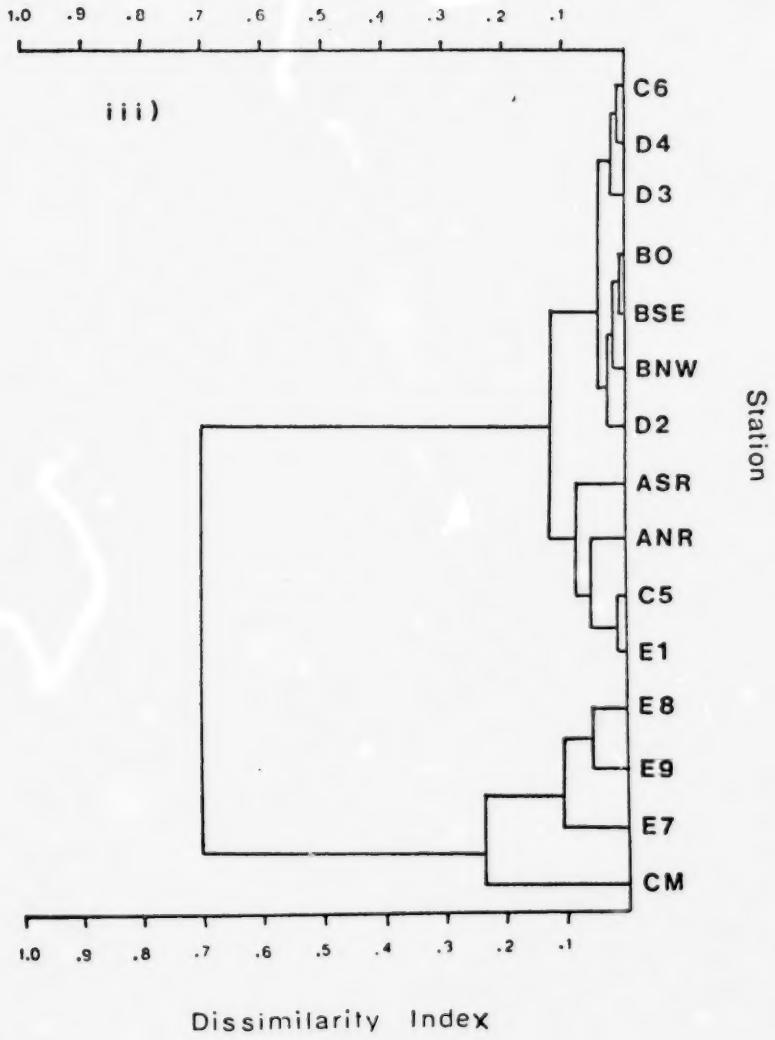
TAXON	ASR 1	ASR 2	ANR 1	ANR 2	BNW 1	BNW 2	BO 1	BO 2	BSE 1	BSE 2	CM 1	CM 2	C5 1	C5 2	C6 1	C6 2	D2 1	D2 2	D3 1	D3 2	D4 1	D4 2	E1 1	E1 2	E7 1	E7 2	EB 1	EB 2	E9 1	E9 2
ORDER CUMACEA																														
Diastylis alaskensis	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diastylopsis tenuis	0	0	0	0	0	0	0	0	8	0	6	13	0	0	1	0	2	1	1	12	4	6	0	0	0	0	0	0	0	0
Eudorella pacifica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	24	68	78	34	38
Cumacean	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cumella vulgaris	21	15	5	42	4	7	0	0	95	999	1	0	0	0	0	0	0	1	1	0	3	0	0	0	0	0	0	0	0	0
Lamprops quadriplicata	9	2	5	0	6	0	1	0	0	0	0	0	0	0	0	0	4	16	0	2	0	0	0	0	0	0	0	0	0	0
Cumella sp.	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ORDER LEPTOSTRACA																														
Fam. Nebaliidae																														
Nebalia pugettensis	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0
ORDER TANAIDACEA																														
Sinelobus stanfordi	178	65	0	1	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptochelia dubia	0	0	1	0	0	0	0	1	1	0	2	0	57	10	107	126	0	0	11	1	219	450	32	108	0	0	0	0	0	0
ORDER ISOPODA																														
Synidotea bicuspida	0	0	2	0	3	1	1	0	1	0	15	12	0	0	0	0	0	0	3	3	0	1	1	1	0	0	0	0	0	0
Idotea resecata	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Idoteid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Synidotea sp. juv.	0	0	0	4	0	4	2	0	0	4	45	16	2	0	1	6	0	0	8	8	19	17	2	5	0	0	0	0	0	0
Pleurogonium rubicundum	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Munna ubiquita	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ORDER AMPHIPODA																														
Ampelisca agassizi	0	0	0	0	0	0	0	0	0	0	2	0	89	28	112	6	0	1	12	36	107	306	80	142	1	0	0	0	0	0
Ampelisca pugetica	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0
Ampelisca careyi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Atylus collingi	0	2	3	3	2	1	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Guernea reduncans	0	0	0	0	0	0	0	0	0	0	11	5	30	22	0	18	0	0	0	0	27	2	15	20	0	0	0	0	0	0
Photis brevipes?	0	1	15	7	0	2	0	0	0	0	55	68	98	315	70	63	0	1	14	17	103	391	7	43	0	0	0	0	0	0
Cheirimedia sp.	0	0	20	11	0	4	0	0	0	0	0	1	146	1	111	117	0	1	0	0	383	182	70	176	0	2	1	9	2	6
Protomedia fasciculata	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	5
Corophium acherusicum	78	74	451	287	21	68	2	1	198	500	0	1	157	33	0	0	2	0	0	0	4	0	0	0	0	0	0	0	0	0
Ischyrocerus anguipes	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ampithoe sp.	0	1	0	0	0	0	0	0	6	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monoculodes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Westwoodilla caecula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Synchelidium shoemakeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grandifoxus sp.	0	0	0	0	0	0	0	1	0	0	10	3	2	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0
Foxiphalus sp.	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterophoxus oculatus	0	0	0	0	0	0	0	1	0	0	0	0	10	2	31	22	0	9	0	0	31	36	11	10	0	0	0	0	0	0
Rhepustorius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	9	17	24	17	14
Lysianassid spp.	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	0	0	0	0	0	0	0	0	0	0
	3	0	0	1	0	0	0	0	0	0	0	0	46	26	163	122	0	0	0	0	180	210	57	102	7	0	0	0	0	0

Appendix 2. (continued)

TAXON	ASR		ANR		BNW		BO		BSE		CM		C5		C6		D2		D3		D4		E1		E7		E8		E9	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Lepidopecreum sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Allorchestes angusta	0	0	0	0	0	0	0	0	8	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melita dentata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Caprella sp.	0	1	6	2	29	172	1	2	1	8	0	0	6	0	0	0	0	0	0	0	5	6	1	6	0	0	0	0	0	0
Unid. Amphipods	0	1	0	4	0	1	0	0	9	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanaidacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	0	0	0	0	0	0	0	0
Phoxocephalidae	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
Podoceridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
ORDER CIRRIPEDIA																														
Balanus crenatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
ORDER DECAPODA																														
Pinnixa occidentalis	0	0	0	0	0	0	0	0	0	0	0	0	7	1	1	2	0	0	0	0	2	11	2	2	0	0	0	3	2	0
Brachyuran larva	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cancer magister	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0



Appendix 3. Dissimilarity matrices of i)geographic distance between stations and ii) differences in %silt/clay between stations and iii) differences in % volatile residue between stations.


1.0 .9 .8 .7 .6 .5 .4 .3 .2 .1
iii)
C6
D4
D3
BO
BSE
BNW
D2
ASR
ANR
C5
E1
E8
E9
E7
CM
Station
1.0 .9 .8 .7 .6 .5 .4 .3 .2 .1
Dissimilarity Index

Distance Matrix: M=200 species N = 15 stations

Conditional on clusters defined by rpevious level
Linkages for (random) tree 1 (= abundance data matrix)

Linkage	Station (1)	station(2)	dissimilarity
1	13	14	0.33
2	8	12	0.36
3	8	11	0.43
4	13	15	0.45
5	1	2	0.46
6	4	9	0.59
7	4	10	0.63
8	6	8	0.66
9	1	5	0.66
10	6	7	0.73
11	1	3	0.79
12	1	6	0.86
13	1	4	0.88
14	1	13	0.97

Station Numbers for linkages

1	ASR
2	ANR
3	BNW
4	BO
5	BSE
6	CM
7	C5
8	C6
9	D2
10	D3
11	D4
12	E1
13	E7
14	E8
15	E9

LINKAGES FOR (REFERENCE) TREE 2 (= distance matrix for lat./long.)

K	E(K)	F(K)
1	3	4
2	6	11
3	3	5
4	1	2
5	1	3
6	9	12
7	7	8
8	14	15
9	6	10
10	7	14
11	6	13
12	6	9
13	1	7
14	1	6

FOWLKES-MALLOWS STATISTIC
CONDITIONAL ON CLUSTERS DEFINED BY PREVIOUS LEVEL
CONDITIONAL ON CLUSTER SIZES
(WALLACE MODIFIED VALUES ARE IN PARENTHESES)

K1	K2	FM STAT	MEAN	STD. DEV.	PROB.
14	14	0.000000	0.009524	0.097124	1.0000
			0.009524	0.097124	
13	13	0.000000	0.010989	0.073306	1.0000
			0.019048	0.096349	
12	12	0.000000	0.014804	0.063674	1.0000
			0.038095	0.095768	
11	11	0.000000	0.014682	0.051396	1.0000
			0.052164	0.093314	
10	10	0.113961	0.022547	0.045128	0.1818
			0.083571	0.091342	
9	9	0.102062	0.119851	0.055345	0.5778
			0.093314	0.087137	
8	8	0.087706	0.113939	0.053352	0.6667
			0.108588	0.085250	
7	7	0.222375	0.179022	0.051311	0.2857
			0.128483	0.084764	
6	6	0.322749	0.218859	0.053031	0.0952
			0.147542	0.082811	
5	5	0.307793	0.294894	0.057441	0.4000
			0.185653	0.080147	
4	4	0.400099	0.306584	0.066984	0.2000
			0.214233	0.079272	
3	3	0.332564	0.456522	0.082459	1.0000
			0.343650	0.056142	
		(0.200000	0.213333	0.067526)	
2	2	0.539437	0.533344	0.048943	0.6667
			0.564963	0.037534	
		(0.289875	0.329780	0.058675)	

LINKAGES FOR (REFERENCE) TREE 2 (=distance matrix for silt content)

K	E(K)	F(K)
1	8	11
2	5	9
3	4	10
4	3	8
5	4	5
6	7	12
7	3	4
8	6	7
9	3	6
10	14	15
11	1	3
12	1	2
13	13	14
14	1	13

FOWLKES-MALLOWS STATISTIC
CONDITIONAL ON CLUSTERS DEFINED BY PREVIOUS LEVEL
CONDITIONAL ON CLUSTER SIZES
(WALLACE MODIFIED VALUES ARE IN PARENTHESES)

K1	K2	FM STAT	MEAN	STD. DEV.	PROB.
14	14	0.000000	0.009524	0.097124	1.0000
			0.009524	0.097124	
13	13	0.000000	0.010989	0.073306	1.0000
			0.019048	0.096349	
12	12	0.288675	0.012248	0.061379	0.0385
			0.032991	0.093817	
11	11	0.182574	0.202963	0.053488	0.8485
			0.052164	0.093314	
10	10	0.125988	0.138178	0.049619	0.6727
			0.075593	0.091349	
9	9	0.223607	0.126912	0.049915	0.1556
			0.085184	0.089136	
8	8	0.269680	0.167593	0.059741	0.1111
			0.141261	0.077025	
7	7	0.283069	0.264112	0.067664	0.3214
			0.168224	0.078313	
6	6	0.346410	0.384819	0.083848	0.6190
			0.247436	0.054774	
5	5	0.473557	0.400946	0.084000	0.2000
			0.281557	0.059804	
4	4	0.484332	0.486222	0.100526	0.6000
			0.334284	0.042969	
3	3	0.754046	0.564507	0.147072	0.1667
			0.505211	0.072601	
		(0.725542	0.443861	0.082185)	
2	2	1.000000	0.772235	0.166079	0.3333
			0.657143	0.059428	
		(1.000000	0.507143	0.085428)	

LINKAGES FOR (REFERENCE) TREE 2 (=distance matrix for %volatile residue

K	E(K)	F(K)
1	8	11
2	4	5
3	8	10
4	3	4
5	7	12
6	3	9
7	3	8
8	2	7
9	14	15
10	1	2
11	13	14
12	1	3
13	6	13
14	1	6

FOWLKES-MALLOWS STATISTIC
CONDITIONAL ON CLUSTERS DEFINED BY PREVIOUS LEVEL
CONDITIONAL ON CLUSTER SIZES
(WALLACE MODIFIED VALUES ARE IN PARENTHESES)

K1	K2	FM STAT	MEAN	STD. DEV.	PROB.
14	14	0.000000	0.009524	0.097124	1.0000
			0.009524	0.097124	
13	13	0.000000	0.010989	0.073306	1.0000
			0.019048	0.096349	
12	12	0.250000	0.013812	0.059570	0.0513
			0.038095	0.095768	
11	11	0.166667	0.188045	0.053540	0.8485
			0.057143	0.093929	
10	10	0.142857	0.151178	0.048842	0.6909
			0.066667	0.091643	
9	9	0.223607	0.126912	0.049915	0.1556
			0.085184	0.089136	
8	8	0.269680	0.167593	0.059741	0.1111
			0.141261	0.077025	
7	7	0.226455	0.263819	0.066621	0.8571
			0.168224	0.078313	
6	6	0.258199	0.286929	0.063373	0.6190
			0.184428	0.073327	
5	5	0.303488	0.308872	0.062712	0.5333
			0.219668	0.073929	
4	4	0.389249	0.387286	0.067419	0.6000
			0.244671	0.071445	
3	3	0.688875	0.538407	0.133237	0.1667
			0.470056	0.074081	
		(0.647150	0.397535	0.084507)	
2	2	0.894002	0.691297	0.144228	0.3333
			0.617874	0.056028	
		(0.844406	0.435570	0.082955)	